Observation of Creep on Valley Fault System in Republic of the Philippines by InSAR and leveling survey

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Many ground deformations have been occurred by earthquakes and volcanic activities in Republic of the Philippines. The monitoring using InSAR, which is capable to observe a wide area, as well as GPS measurement and leveling survey, which are capable to measure land displacement less than centimeter, is actively conducted in this country. The development of geothermal energy, a typically conducted by volcanic countries, is also promoted by operating many geothermal power plants. This development requires monitoring environmental effects such as land subsidence. In the past studies, the ground deformation due to pumping of geothermal fluid and the activity of Taal volcano were clarified by InSAR using JERS-1/SAR data. At the same time, the ground deformation, which had no relation with volcanic activities or geothermal power generation, was detected. This deformation is corresponded to creep displacement around an active fault in the south part of Valley Fault System, which was analyzed by Y. Kinugasa et al., (∗1). In this study, the authors detect the creep displacement in the south part of Valley Fault System by InSAR using JERS-1/SAR and ENVISAT/ASAR as well as by leveling survey, and report the results of them.

Fault creep is a phenomenon shown around huge faults such as San Andreas Fault in California or North Anatolia Fault in Turkey. The Western Valley Fault (known also as the Marikina Fault) is one of them that are showing fault creep. The Western Valley Fault is a north-south trending active fault in the Metro Manila district, central Luzon. Buildings and road pavement are damaged by vertical displacement of the ground where the central segment of the fault passes through.

The authors have carried out leveling survey on six lines crossing the fault 2 to 4 times every year since 1999. On two lines of them, cracks on the pavement were seen but no displacement was detected. On the other four lines, however, a clear displacement was detected. As for the survey line where the creep displacement was detected, the amount of average displacement was 0.6 to 1.4cm/year before 2004, while the amount of average displacement was 2.0 to 4.2cm/year after 2004. This shows that the rate of displacement has been rapidly increasing by time. Two factors are considered to be the causes. One is excessive pumping of underground water to meet increasing demand of water as urbanization drastically develops, and another is tectonic factor.

As the results of InSAR processing using JERS-1/SAR data observed from 1993 to 1998, it was extracted a displacement which the east side of Valley Fault had moved down. The amount of the displacement was approximately 6 cm per 3.7 years. As the result of InSAR processing using ENVISAT/ASAR data in 2003 also detected displacement in the same region which the east side of the fault was moving down (2 cm/280 days). The amount of displacement of Valley fault measured by InSAR was increasing with passing time from 1.6cm/year to 2.6cm/year. This was in accordance with the results of leveling survey.

Meanwhile InSAR processing detected the total of 5 displacements, which are assumed to be caused by land subsidence around Manilla. The largest amount of subsidence was approximately 30 cm/3.7 year.

For the future, we will make plan for the simultaneous observation using ALOS/PALSAR, launched in January 2006, and leveling survey, that leads the creep observation in this area and clarification of the mechanism.

(∗1) Y. Kinugasa, K. Papiona and R. Rimando (2006) : Creep-slip of active faults in Asia, an example from the Valley Fault System in Metro Manila, Eos Trans. AGU, 87(36), West. Pac. Geophys. Meet. Suppl., Abstract T34B-04 INVITED, July, 2006.